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ABSTRACT

A definition and a general description of communication that makes use of the insights of linguistics and psychology are presented in this paper, along with a conceptual model of communication that incorporates a systems approach. Following a lengthy discussion of the components required for a communication exchange, the systems approach model is described and schematized. The concepts image (the locus of a plan) and plan (a chain of images) are then related to the acts of sending and receiving messages, and the element of intentional and unintentional communication is discussed. Finally, the contributions from the fields of behavioristic and neobehavioristic psychology and linguistics are discussed, and it is concluded that a semantic theory which recognizes the plan/image duality in communication systems will have to be formalized. (RB)

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Systems, Purposes, Images, Plans

A Communication Model

(Presented at the International Communication Association meetings, April 1974)

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In what follows you may recognize the author as a refugee, to some extent from linguistics, but even more from psychology. What I wish to do is to offer a definition and general description of communication which will make use of the insights of those disciplines without falling into the trap of the single-process model, and at the same time use technical terms as near as possible to everyday speech. I think both those criteria are most likely to be satisfied by using a systems approach.

Systems and Purposes

What sorts of things are said to be the agencies of communication--its senders and receivers? To answer this, let's boil down the world of our experience into its more basic parts and relations. The simplest mechanistic view pictures a billiard ball world in which objects of various sizes trade energies with each other by a variety of interactions: mechanical impact, heat transfer, electromagnetic effects. As long as each interaction balances the books--that is, as long as we know where the energy came from and how it is spent-- this simple picture can be maintained.

But the world is full of objects which fail--at least in the short run, and sometimes for a very long time--to balance the energy books. An incoming stimulus which might be expected to move, heat, or damage the object, or at least be transmitted through it like electricity along a wire, instead seems to do nothing: it is as if the energy had disappeared.

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Or, worse yet, the object may respond to the stimulus, but in an unexpected manner. A thermostat which has made no response to five degrees of temperature increase in a cold house will answer the next half degree by shutting off the furnace. A rifle trigger, slowly squeezed, will suddenly release catastrophically dangerous chemical-mechanical events. A rock which has moved imperceptibly under repeated sledge hammering will on the next blow fracture cleanly from top to bottom. An anthropomorphic imagination would be tempted to picture a perverse intelligence in each of these things, bent on making its own choices, regardless of what we do to it.

But before we reject such a fancy, let's consider what common element has tempted us to it. Each of those objects--and we may certainly add human beings to the list--stores and converts energy in such a way that its response can only be understood and predicted by adding knowledge of its internal structure to what we know of the incoming stimulus. What inspired us to hunt for demons, then, was a perfectly legitimate similarity between human beings and other objects: They share--in varying degrees, of course--the property of internal organization. Or, to put it another way, they are systems.

A distinction among systems may help us to focus on an important attribute which they share. Of those mentioned above, the thermostat and the rifle are artificial, the rock and the human being natural. Since the artificial systems required some human intervention to bring them into existence, we may treat them for the moment as special cases, serving purposes beyond themselves. But the crystal structure of a rock and the psychobiological structure of humankind arise, as far as we can tell, from

the ability of certain combinations of events to maintain and propagate themselves in the face of whatever their universe may be. Since survival is the payoff, any change in a natural system which will help it to stay intact and/or to reproduce will tend to be preserved, until we may eventually say that the purpose of survival has, by natural selection, been built in to the system. The crystal maintains and propagates its structure in a relatively simple environment of physico-chemical forces, while human beings must answer to a much more complex universe. Artificial systems will not have the purpose of survival unless it is deliberately built in, and we have not generally found this worth the trouble. (Various overload cutoffs, such as circuit breakers and fuses, in electrical systems, and the impact-absorbing bumper are exceptions.) The artificial system, however, does "have" whatever purpose was designed into it, answering to some limited portion of its environment.

The relationship I have labeled with the expression "answering to" appears at many levels. In a primitive mechanical system natural selection contributes only those structural elements which resist the usual surrounding pressures: the answering is, say, a particular crystal structure which is equivalent to, or represents, these pressures. In a complex biological system, built on the evolutionary accumulation of experience, distant, future, or only imagined environments are answered to, or represented, in advance. Also represented must be some part of the system itself, all the way up to the full reflexivity of humans and possibly some other primates--the answer to an answer, so to speak. Representation may, of course, include coding, so that the image need not actually resemble what it represents. Indeed, we might reflect that the origin of coding lies precisely in the fact that events do not generally answer to each other by identity, but by complementation.

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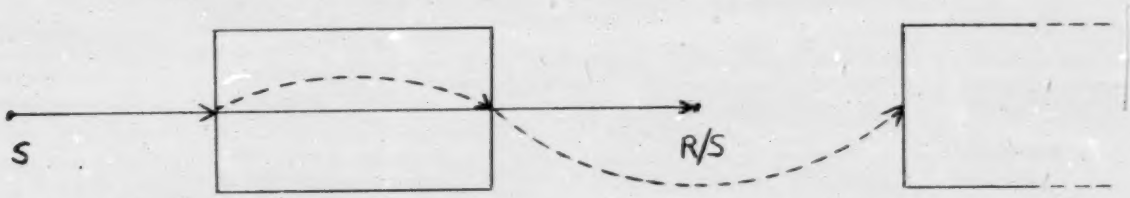
We entered into this description of systems-with-purposes-in-environments in order to discover the agencies of communication. A diagram may help us to picture the relationships I have in mind. Taking the observable stimulus and response events as our starting nodes, we try to trace a simple path (straight solid arrow) through some unknown object on the assumption that its parts will be affected independently (without relation to each other), these effects obeying the laws of chance and giving us an averaged response directly predictable from the stimulus. But we do not always find the "empty space" of randomness. Instead, we encounter a set of internal relations which upset or greatly complicate our predictions, and whose results are sufficiently independent of the environment and sufficiently consistent so that we mark them as having purpose. The greater this complexity, the more we ascribe to it "systemness", or consciousness, as some writers, such as Pierre Teilhard de Chardin, have broadly used the term. This more complex path is represented by the upward-curving dotted arrow.



But our diagram allows us to exploit also an intriguing property of networks--namely, that interesting things happen when nodes and paths are exchanged with each other. (Technically, this property is called duality.) If we now take the system (or consciousness), which was our process-path before, as a node, and trace a process-path from it to another system (downward-curving dotted arrow), the result is what

we call communication. The former response node now becomes a channel (path) connecting the two systems, and from the second system's viewpoint it is a stimulus.

Does that mean that just any inter-system event, like two people bumping into each other on the street, will therefore constitute communication? Let's look at how we would answer that in everyday usage. We'd say no, unless one of the parties can be said to have gained information--for instance, to have concluded that the other person must be in a hurry, or arrogant, or anxious. But there is a further condition: the information gained must be of a certain kind. If I collide with another pedestrian, I may decide, ruefully, that he weighs 250 pounds or is travelling at 20 miles per hour. That's new information, but it doesn't come to me from that other person in his character as a system. We have seen that systems have either natural survival-related purposes keyed to their general environment or artificial purposes designed for a special segment of the environment. I wish to argue that we (should) speak of communication only when what passes through the channel is information about another system as a system, that is, having a purpose in a particular environment.

Surely such a definition is no problem with respect to interpersonal contacts. But it has perhaps unexpected results when applied to the borderline cases. For instance, if a television ground monitor is watching programs relayed by a satellite, he is not in communication with the satellite, but with the original sender of the program. If he is checking signals put out by the satellite in order to aim an antenna at it, he is not in communication, but merely observing it. However, if he is interpreting data sent out by the satellite on its internal temperature,

pitch, yaw, and roll, or amount of incident light, then by this definition he is in communication with it.

A similar distinction might be made between the biologist studying the interior mechanics of an ecosystem (not communicating) and the naturalist exploring the way a larger set of conditions has shaped the responses of that system. The latter is communicating, we might also say, because he is focusing on the meanings of phenomena. The expression "communing with nature", when it is intended as more than a mildly amusing cliche, implies this sort of relationship.

Although I referred above to the possibility of regarding another person as merely a mass with a velocity, the fact is that in the normal range of interaction with other people we are always in communication. Bodily position, gestures, direction of gaze, pupil size, grooming, clothing style--all of these and many more characteristics are treated by us, often "automatically", as cues to the other person's usual or momentary relationship with his surrounding environment. This habitual sending and receiving of personal cues is so dependable that communication theorists frequently say "You cannot not communicate." For exceptions we must go to abnormal states such as those occasionally reported by schizophrenics: a feeling that one is hollow, empty, and that the surrounding world is flat, colorless, and without meaning. Still, such a person, while he may be incapable at that moment of receiving communication--and perhaps only later can he deliberately send-- may be understood by a clinician--that is, the clinician may be able to "read" his behavior as cues to his current relation to his surroundings.

This last case suggests two details of definition that we will have to face in spite of paradox: First, that communication may take place without awareness; second, that it may be entirely mistaken. The expert broken-field runner or the expert pivot man on a basketball team would probably be unable to tell us--or himself--what cues in his opponents' and teammates' behavior make him able to project their purposes into a new set of positions and vectors 5, 10, or 15 seconds in the future, but the consistency of his performance makes it impossible for us to deny that communication has taken place. With respect to more commonplace experience, all of us act, at one time or another, on intuitions about the mood or intentions of others. If pressed, we might hazard an explanation of such a hunch on the basis of fleeting facial expression, gesture, or tones of voice. But normally we are not so pressed, and the intuition seems to present itself ready made, not as an induction from specific observations. Thus, communication without awareness of any message as such. And of course this phenomenon may operate in both directions, giving rise to "love at first sight" or to mysterious mutual antipathies.

If we drop awareness as a necessary condition of communication, we are forced to take the second step of dropping accuracy. Even apart from philosophic arguments about the elusiveness of truth, we know clinically that behavior without awareness is likely to reflect old motivations and memories which wouldn't stand the spotlight of adult examination. Our reading of other people's gestures may be based on a childhood reaction to similar gestures by a parent--a reaction we accept only because we are unaware of it.

But we need not rest our case on a relatively exotic instance. Any time we exchange words with someone, those words carry meanings somewhat different for the two of us. How different? There is no accepted measure. How different do they have to be in order to invalidate the conversation? We can't answer that either unless we know what the particular purpose of the conversation is --or might become. Better admit defeat: communication may be just plain wrong.

Please don't regard that conclusion as merely an arbitrary fallout from sloppy definition. Consider, rather, that it may yield an extremely useful tendency to caution for all of us. All too often communication is touted as a panacea for social and personal problems, with the unstated assumption that it must lead to truth. But all too often we may instead gather misinformation and pile one misunderstanding on another in a communicative transaction. Meetings arranged across generation or culture boundaries to "promote mutual understanding" may, perhaps even for reasons we are unaware of, leave the participants with their mistaken prejudices deepened or embittered.

To summarize, then: all that we ask of communication is that it involve two systems in an interaction such that at least one of them gains from the stimuli put out by the other--intentionally or not--some information about the other's representation of its environment, and therefore, by implication, of its purposes. The definition is satisfied even if that information is false.

The Image

We shall call the representation which a system carries of its environment its image -- or we may refer to certain parts of the representation as images. In this we follow the usage of Kenneth Boulding

in his book, The Image (1956). Boulding, however, seems at times undecided about how far he wishes to extend the notion of image. When he says, with hesitation, that fish and reptiles have "some sort of image of their environment" (p. 24), he seems to lean toward a learning criterion. But earlier in the same paragraph he suggests that "the image of the plant may be thought of as a property of its genes alone". I take the latter usage to be preferable. That is, if we accept the earlier argument--that the effect of repeated evolutionary testing is to favor aggregations with a purpose of surviving, plus subordinate purposes serving that end (i.e., systems)--then in seems reasonable to speak of some level of image in all such aggregations. We shall return shortly to the relation between purpose and image.

First, however, some comment on the possibility of images in social organizations. Boulding concedes that social organizations are open systems: they have "a through-put of individuals", a pattern of development, and tend to seek out particular goals through varied and internally complex means, adjusted by means of feedback. But, he insists, it is the human member that "has the image, not the organization. The image structure lies wholly within the frames of the individuals composing the organizations." If this were strictly true, I submit, we would not find social systems at all, only momentary adjustments by casual groups of individuals.

The image embodied in a social system is, of course, much cruder than what an individual can handle. No doubt that is what Boulding had in mind. Still, it might be instructive to reflect on some of the elements of the image of education embodied in a university, for instance. We would see it departmentalized, fragmented into small time units, packaged in semesters, and built around personal interaction. Regardless of their

utility, any one of these characteristics might clash with the images held by individual employees of the university. But the permanence of a social system will always depend in part on its ability to induce a sufficient number of people to incorporate a significant portion of its relatively simple image into their more complex ones.

The purpose of these comments on Boulding's Image has been to establish that having or embodying an image is a property of systems of all levels of complexity.

The Plan

I have argued that the image is a concomitant of the purposeful character of systems. But a more specific analysis is needed of the relation between image and purpose. This need was recognized by Miller, Galanter, and Pribram in their book Plans and the Structure of Behavior (1960). They were aware that Boulding's image-holding organisms, like Tolman's cognizing rats, might end up "lost in thought" if there were nothing to link image with action.

Their answer was the formal concept of the plan. The structure of a plan is a TOTE sequence -- an acronym for Test-Operate-Test-Exit -- which is patterned after a computer program segment or subroutine. A system may be said to "want" something if an initial Test comparison of its present state with a stored image of a positively valued state yields a discrepancy. The plan then calls for the system to enter the Operate step, in which the present state is changed. Another Test is then performed, and if the discrepancy is close enough to zero, the system Exits from that particular plan. Naturally, the Test-Operate sequence will be repeated

as many times as necessary to reach this goal, or until some higher level TOTE unit interrupts it to satisfy higher priorities. In addition--and this is a very important feature of the model--any Operate routine may itself consist of one or a sequence of other TOTE units, so that any plan may turn out to be an indefinitely complex hierarchy of subplans.

Miller, Galanter and Pribram say that "the central problem of this book is to explore the relation between the Image and the Plan," and this they do with a great deal of success. But this success lies primarily in the demonstration that Image and Plan are concepts useful together in describing human behavior. I want to suggest here that we take the further step of seeing these concepts as mutually defining and as representing phenomena that produce each other in working systems. And beyond that--harking back to my earlier discussion -- we must see communication as a kind of plan bringing the images in the sender to bear upon the images in the receiver, where those images in turn are part of their respective systems' master plans of survival: and so on in an endless duality of plan and image.

The Model

The connection we need, I submit, lies in the vague phrase used earlier: that the internal organization (i.e., image) of any system becomes what it is by "answering to" the environment. To fathom what is hidden in this "answering"process, we would do well to consult Piaget's (1954) ideas on the learning process. But please understand that this account is streamlined and edited to fit our present concerns.

Piaget's starting point is the schema, a circuit from environment

to organism to environment in which a stimulus gives rise to a more or less complex response. The circuit is "wired in" to the system: in other words, it is a plan which runs off in a sequence that depends on the structure, or image built into the nervous system. But that image is the result of a developmental plan of construction operating at the biochemical level, which in its turn originates in the genetic image coded in DNA molecules. And so on. The schema operates primarily through the principle of assimilation: Any one of a wide range of stimuli is sufficient to trigger a grasping, or a sucking, or a head-turning reflex. At this early stage, Piaget emphasizes, the object has no independent identity for the infant. To put that another way, the object is part of the infant's plan, but there is no equivalent image to go with it, except the anatomical structure of the reflex.

Taking some liberties with Piaget's carefully graded levels, we may describe a second stage in which the initial schemas get modified by the learning process. Specifically, some runs through the schema are followed by satisfactory states, others by unsatisfactory. Although the original schema entails a rather wide assimilation of different stimuli into the same pattern, adding varying outcomes to a schema with some degree of predictability results in enough hunting by the system to produce consistent variations in the schema. (Now we have, by the way, the minimum material necessary, according to George Kelly (1955), for a construct: At least two similar experiences, and at least one experience in relevant contrast with them.) The variation in the schema to answer to the contrast, Piaget would call accommodation. So far we are still talking about plans and their elaboration.

At the next stage, a new note begins to creep in. The learner has a repertoire of plans to answer to increasingly varied situations. Many of

these plans, of necessity, overlap. That is, they use the same parts of the body or, more significantly, the same parts or assemblies or patterns in the nervous system. When an action is learned with one hand, for instance, it is already less difficult to learn it for the other. And the data on synesthesia suggest that a sequence of events recorded in one sense modality is quite easily carried over into another - perhaps most easily by those least inclined to "think" about what they are doing. As these overlaps pile up, our nervous system becomes more and more able to abstract the common elements from the plans and store them separately, so that they are available for use in new combinations. At the same time, actual contact at the organism- environment border becomes less and less necessary.

The learner is now able to "run through" a plan internally, without actually receiving the appropriate stimulus or making the answering motions. Or he may instead simply "refer to" those abstracted overlapping elements from different plans - and if he does this he is using for the first time his own rudimentary image. To the extent that this abstractive process takes place, Piaget would say, to that extent the environment takes on objective existence from that person's viewpoint.

We may add here a final stage of learning, one in which the rehearsal even of internal plans is no longer necessary, and the learner has integrated the abstractions he formed in the previous stage into a set of fully organized and related internal images, corresponding to a fully objectified external world. (Whether these two structures are really distinguishable I leave for the metaphysicians to figure out.)

This learning model is of course much idealized. My notion of the flesh-and-blood learner is that he is at all these levels simultaneously

with respect to different fields of experience: most adults present a well-integrated image of, say, visual experience, but many are aural assimilators. But even allowing for a much more complex reality than is here presented, we may now state a fairly simple summary of the relationship between image and plan:

1. An image is the locus of a plan. This expression is used exactly in the geometric sense. If we are told to find the points equidistant from a given point, that is a plan. Executed enough times so that the points all run together, it yields an image not found in any single execution, but in the overlap alone.

2. A plan is a chain of images. Consider the original characterization of a plan as a TOTE unit, with practically unlimited nesting possibilities. Each test segment of such a nest contains an image to be used as a test criterion. As each test is passed, in order according to the TOTE organization of the plan, the organism passes on to the next test image. We see, then, that a chain of images is a proper shorthand for the whole plan.

Some Integrations and Extensions

Early in this paper, we considered a definition of communication which ties it inseparably to the concepts of system, image, and purpose. Building on the preceding discussion of plan and image, we are in a position to round out our communication model by using those terms as the labels in the original duality. One system contains an image. For that image to reach another system, a plan must be executed. In the case of unintentional communication, the plan is a set of directions in the receiver which includes general scanning, following a specific sequence of stimuli, interpreting the sequence, and committing the result to some kind of storage

which may or may not involve alteration of the receiver's image. If the communication is intentional, there is also a plan at the sender's end, including selection of the message to serve some higher-level plan, and an encoding and transmitting process. As noted above - in different terms - there is no guarantee that the sender's and receiver's plans are perfectly matched, though some minimum correspondence at the coding level must be present for any image at all to be transmitted.

"Plan" and "image" are reifications. You may find it preferable to avoid the pitfalls of nominalization by thinking of them as two basic processes. For that purpose, Jakobson and Halle, in Fundamentals of Language (1956), have provided the terms "sequence" and "substitution". They point out that different writing styles may exhibit the dominance of one or the other process: that (the extreme) Prose is narrative and circumstantial, while Poetry substitutes elements metaphorically and symbolically. They also describe cases of aphasia where one of the processes is severely disturbed while the other is left untouched. Lacking the sequence process, one aphasic must communicate by blurting out clusters of labels--replacing the automatized plan of grammar, which he has lost, with a makeshift and socially unstandardized plan of his own. Another aphasic, lacking the substitution process, may produce streams of familiar grammatically ordered speech, but if he hesitates or ventures into unfamiliar sequences his vocabulary is lost, unless it can be bolstered by adding nonverbal context.

Considering the generality of the plan/image (sequence/substitution) distinction, we may be emboldened to raise some questions about currently popular theories of language learning. We are often told that the forms of language have their own special innate roots in the human nervous system. Yet when the accidents of particular languages are stripped away, the

remaining inventory of linguistic universals seems hard to distinguish from a list of cognitive attributes without specific reference to language. We should not forget--under pain of being sliced up by Occam's Razor - that speech utterances are a highly portable, convenient, and pervasive element in nearly every child's experience. The child is overwhelmed with a profusion of plans - i.e., sentences - overlapping in highly stable combinations. Merely allow the child the innate capacity to abstract, and from those overlaps will emerge the linguistic universals, in the guise of the particular forms of the child's native language. In a sense, those linguists who have given us grammatical analyses of young children's language witness by their own behavior to the inductive nature of linguistic learning. How do they discover the form class membership of the child's words -- those generalized images from which grammatical plans are constructed? Why, they record the privileges of occurrence of these words in sequence with other words. What else could they do?

This insistently inductive view, in which linguistic substitution classes grow out of repeated overlapping sequences, throws a somewhat different light on semantic theory than we are accustomed to. Behavioristic and neo-behavioristic psychology have attempted to handle meaning by locating it in chains of stimuli and responses (Osgood et al, 1956). Fixed at the sequence level, they cannot tell us what happened to Helen Keller when she saw that "water" did not merely occur with water, but took its place.

Linguists have gone the other way, for the most part. We have seen a number of sophisticated attempts (Katz and Fodor, 1963; and Chafe, 1970, for example) to absorb semantics into the beautifully defined world of syntax, but they do not work (Weinreich, 1966), because the vagaries of content are always interfering. These theories face disaster, for example,

with the all-too-common problem of prepositions. The machine translators racked their brains for years trying to find common elements in all the uses of single prepositions, but my undergraduate college professor in Anglo-Saxon had a workable alternative. "Once you've decided it's a preposition," he used to say, "just put in any modern English preposition that fits." His solution recognized the fact that preposition choices, in particular, are determined to a very large extent by immediate context rather than by logical derivations.

I submit that a semantic theory which recognizes the plan/image duality in communication systems will have to formalize that distinction in the discussion of word meanings. Part of the job has been done: the term "feature" has been adopted by linguists - originally from the domain of phonology - to label the various substitution classes to which a word belongs. Among structural anthropologists, the equivalent term is "component", while cognitive psychologists, depending on whether they are experimental or clinical in their inclinations, have adopted "dimension" and "construct" respectively. The sequence element has been recognized, but not formally. I suggest that the term "valence", used just as it is in chemistry, is a natural choice.

Using such a semantic theory, a programmer designing a computer translating system, for instance, would set up a lexicon in which each word entry carried both a list of features (beginning with form class membership and working down to general features - animate/inanimate, good/bad, etc. - and then to particular features - quiet/noisy, wet/dry, familiar/strange, etc.), and a list of valences ranging from the highly organized and obligatory ones we call syntactic rules to the looser relations of observed general co-occurrence.

This quick sketch is by no means a semantic theory. But it may offer a reasonable framework around which one could be built. If this framework does have merit, it is primarily because it reflects the basic processes involved, as I have argued above, in communicative systems.

Like many discussions in systems theory, this paper has run the risk of attempting to stir up excitement about the obvious. Is it, after all, anything more than a mere rediscovery of function and structure? Perhaps not, but it may be that dressing them up in new terms will allow us to explore with a fresh vision the dynamic relationships between them that are necessary to a systems view of communication.

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